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A Bibliometric Analysis of Ocean Plastic Pollution Research: Trends and Future Directions

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ABSTRACT

This study presents a comprehensive bibliometric analysis of global research on ocean plastic pollution to identify key trends, influential contributors, thematic structures, and future research directions. Bibliometric data were retrieved from the Scopus database, covering the period from 2000 to 2024. Using VOSviewer, the study analyzed co-authorship networks, keyword co-occurrences, and temporal evolution of research themes. The analysis included publication trends, authorship patterns, country collaborations, and research clusters. The results reveal a substantial increase in research output, with dominant themes clustering around marine pollution pathways, microplastic impacts, environmental monitoring, and waste management strategies. Keywords such as "plastic pollution," "microplastic," and "environmental monitoring" were central to the field. Influential authors included Jambeck J.R., Law K.L., and Thompson R.C., while the United States, the Netherlands, and Canada emerged as leading countries in terms of productivity and collaboration. Recent research trends show a shift toward sustainability, climate linkages, and circular economy frameworks. The field is transitioning from problem identification to integrated solutions and policy-oriented approaches. Future research should strengthen interdisciplinary integration and promote more inclusive international collaborations, particularly involving regions most affected by marine plastic pollution. This study provides a systematic, visualized mapping of the ocean plastic pollution research landscape and offers strategic insights for academics, practitioners, and policymakers seeking to advance sustainable marine environmental governance.

Keywords: *Ocean Plastic Pollution, Bibliometric Analysis, Microplastics, Marine Debris, VOSviewer*

1. INTRODUCTION

Over the past few decades, the global community has become increasingly aware of the growing environmental crisis posed by plastic pollution in marine ecosystems. Plastics, due to their durability, lightweight nature, and widespread use, have become ubiquitous in modern society. However, their persistence in the environment, particularly in the oceans, has raised grave concerns. It is estimated that more than 8 million tons of plastic waste enter the oceans annually, with this number projected to rise if current production and waste management trends continue [1], [2]. The impacts of ocean plastic pollution are extensive, ranging from entanglement and ingestion by marine fauna to disruption of food webs and the potential introduction of toxic pollutants into human food chains [3].

Scientific interest in ocean plastic pollution has grown considerably since the early 2000s, with research expanding across disciplines such as environmental science, toxicology, marine biology, chemistry, and public health. Innovations in methodologies ranging from satellite imaging to microplastic detection in marine organisms, have enriched our understanding of the sources, pathways, and ecological consequences of plastics in marine environments [4]. At the same time, public awareness and international policy responses, such as the United Nations Sustainable Development Goals (SDG 14: Life Below Water), have further stimulated academic interest in mitigating plastic pollution.

As the body of literature on ocean plastic pollution expands, it has become increasingly necessary to synthesize and map existing research to identify patterns, gaps, and emerging trends. Bibliometric analysis offers a systematic and quantitative approach to evaluate scientific output, collaboration networks, and knowledge evolution over time. Unlike traditional literature reviews, bibliometric methods can handle large volumes of data and uncover hidden patterns by analyzing publication metadata such as keywords, citations, co-authorships, and journal impact [5]. This approach is especially useful in rapidly growing fields where a manual review of all publications would be unfeasible.

Several bibliometric studies have been conducted in adjacent fields such as microplastics research , marine debris, and plastic waste management [6]–[8]. However, a comprehensive and focused bibliometric analysis specifically targeting ocean plastic pollution remains relatively scarce. Such a study would not only help consolidate existing knowledge but also guide future research and policy priorities. By identifying leading authors, institutions, journals, and thematic clusters, researchers and practitioners can better understand the structure and dynamics of this critical research area. Furthermore, the evolving nature of plastic pollution, marked by the emergence of nanoplastics, plastic additive toxicity, and the interplay between climate change and plastic dispersion necessitates a forward-looking understanding of research directions. Bibliometric visualization tools like VOSviewer and CiteSpace provide powerful capabilities for mapping thematic evolutions and detecting research frontiers [9]. A focused bibliometric analysis can thus serve as both a reflective tool for the academic community and a strategic guide for policymakers working toward sustainable ocean management.

Despite the exponential growth of literature on ocean plastic pollution, the field remains fragmented, with limited synthesis of its intellectual structure and developmental trajectory. The lack of a consolidated bibliometric analysis hinders scholars and decision-makers from understanding the evolution, central themes, and collaborative networks within the field. Without such insights, efforts to coordinate multidisciplinary research, allocate funding, and develop holistic mitigation strategies may fall short. There is a pressing need for a comprehensive bibliometric mapping that can illuminate the landscape of ocean plastic pollution research and inform both academic inquiry and policy formulation. This study aims to conduct a comprehensive bibliometric analysis of global research on ocean plastic pollution.

2. METHODS

This bibliometric study adopts a quantitative approach to systematically analyze the development and structure of scientific literature on ocean plastic pollution. The primary data source used in this research is the Scopus database, selected for its extensive coverage of peer-reviewed literature across environmental sciences, marine biology, and related interdisciplinary fields. A comprehensive search was conducted using the keywords “ocean plastic pollution”, “marine plastic debris”, and “plastic waste in oceans” in article titles, abstracts, and keywords. To ensure the relevance and quality of the dataset, only documents published between 2000 and 2024 were included, covering journal articles, conference proceedings, and reviews. Non-English publications and non-scientific outputs (such as editorials or notes) were excluded from the analysis.

Following data extraction, bibliographic information such as authorship, affiliations, publication year, journal source, citations, keywords, and abstracts was exported in CSV and RIS formats compatible with bibliometric software. The dataset was cleaned to eliminate duplicates, irrelevant entries, and inconsistencies in author or institution names (e.g., name variants).

The bibliometric mapping and visualization were conducted using VOSviewer version 1.6.x, a widely used tool for constructing and visualizing bibliometric networks, including co-authorship, co-citation, and keyword co-occurrence maps [9]. Descriptive statistical analysis was used to examine annual publication trends, most prolific authors, institutional and country-level productivity, and journal impact. To capture the intellectual and thematic structure of the field, the study employed co-occurrence analysis of keywords, co-authorship network analysis, and citation analysis. Keyword co-occurrence maps were used to identify research hotspots and thematic clusters, while co-authorship networks revealed collaboration patterns among researchers and institutions. Citation and co-citation analyses highlighted influential articles and authors that have shaped the development of the field.

3. RESULTS AND DISCUSSION

3.1 Keyword Co-Occurrence Analysis

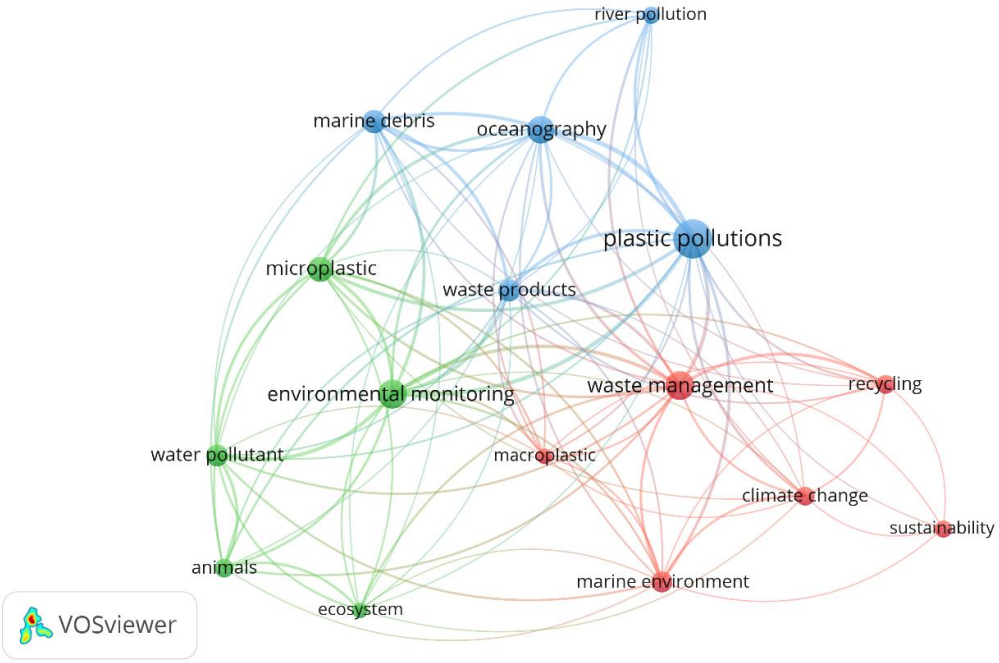

Figure 1. Network Visualization
Source: Data Analysis

The figure 1 is a keyword co-occurrence network map generated using VOSviewer, which visualizes clusters and thematic relationships within the field of ocean plastic pollution research. The nodes represent keywords from scientific publications, and the links between them indicate co-occurrence within the same documents. The color coding signifies distinct thematic clusters, suggesting the main research directions and their interconnectivity. The blue cluster at the top center of the map, anchored by the term "plastic pollutions", represents foundational research themes focused on marine plastic accumulation and its hydrological context. Keywords such as marine debris, oceanography, and river pollution indicate a research emphasis on tracing the origin and transport pathways of plastic waste in aquatic environments. The central placement and dense connectivity of "plastic pollutions" highlight its role as the thematic core of this research field, linking hydrodynamic studies with broader environmental concerns.

The green cluster to the left centers around "environmental monitoring", encompassing keywords like microplastic, water pollutant, ecosystem, and animals. This cluster reflects a strong focus on ecotoxicological impacts of plastic debris, particularly microplastics, on marine organisms

and ecosystems. The tight interlinkages suggest an interdisciplinary convergence between environmental science, biology, and ecology. The inclusion of environmental monitoring as a central node signals the importance of empirical, field-based assessment in understanding and managing plastic pollution effects. The red cluster on the right represents research on waste governance, sustainability, and climate change, as indicated by keywords such as waste management, recycling, climate change, and sustainability. These terms signify a growing scholarly concern with mitigation strategies, policy frameworks, and the alignment of plastic pollution control with broader sustainable development and climate action agendas. The connection between waste management and plastic pollution suggests that solutions-based research is a key component of the field's evolution, addressing upstream causes and circular economy principles.

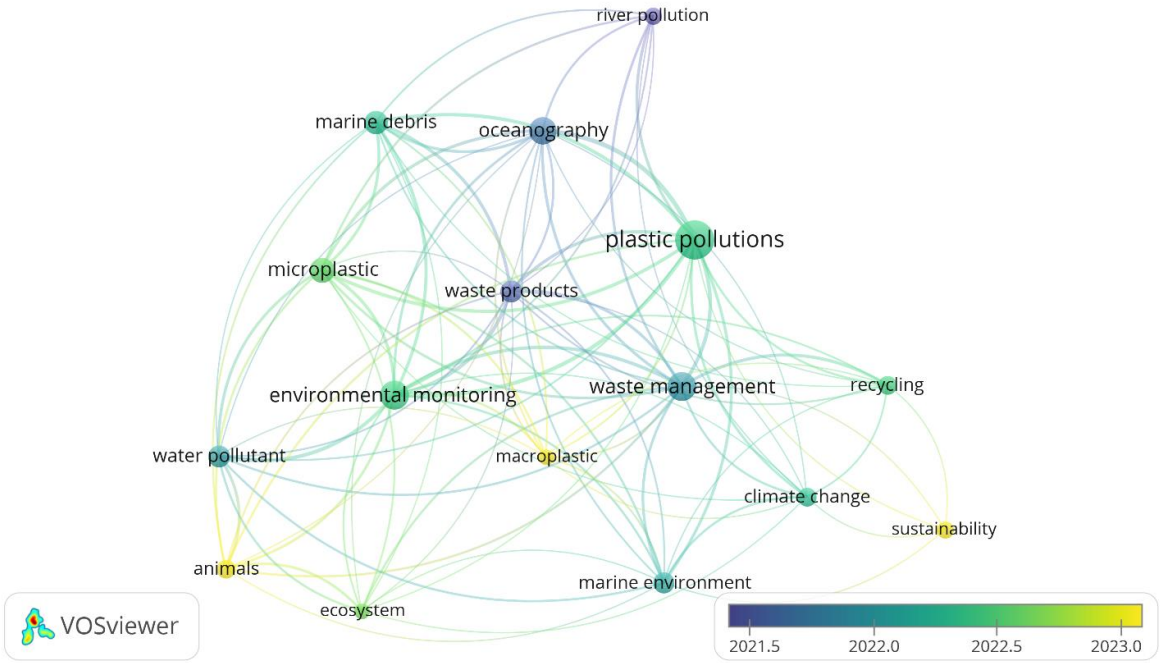

Figure 2. Overlay Visualization

Source: Data Analysis

This overlay visualization displays the temporal evolution of research themes in ocean plastic pollution, with node colors representing the average publication year of the associated keywords. The color scale ranges from dark blue (older research, ~2021) to yellow (more recent, ~2023), allowing us to interpret how topics have developed over time. The core keywords such as plastic pollutions, marine debris, and oceanography are predominantly blue to green, indicating they were established earlier, around 2021–2022. These terms reflect the foundational focus of the field, which historically concentrated on the sources, distribution, and accumulation of plastics in marine environments. Likewise, keywords like waste products and environmental monitoring appear in green, signifying their ongoing but stabilizing relevance within the research landscape. In contrast, keywords like macroplastic, sustainability, climate change, and animals are shaded yellow, indicating emerging or intensifying interest in recent years (2022–2023). This suggests a growing research shift toward sustainability frameworks, climate–plastic linkages, and biological/ecosystem impacts of plastic waste. The appearance of newer terms near nodes such as recycling and marine environment implies a research trajectory toward mitigation strategies, circular economy models, and socio-environmental integration, marking the future directions of the field.

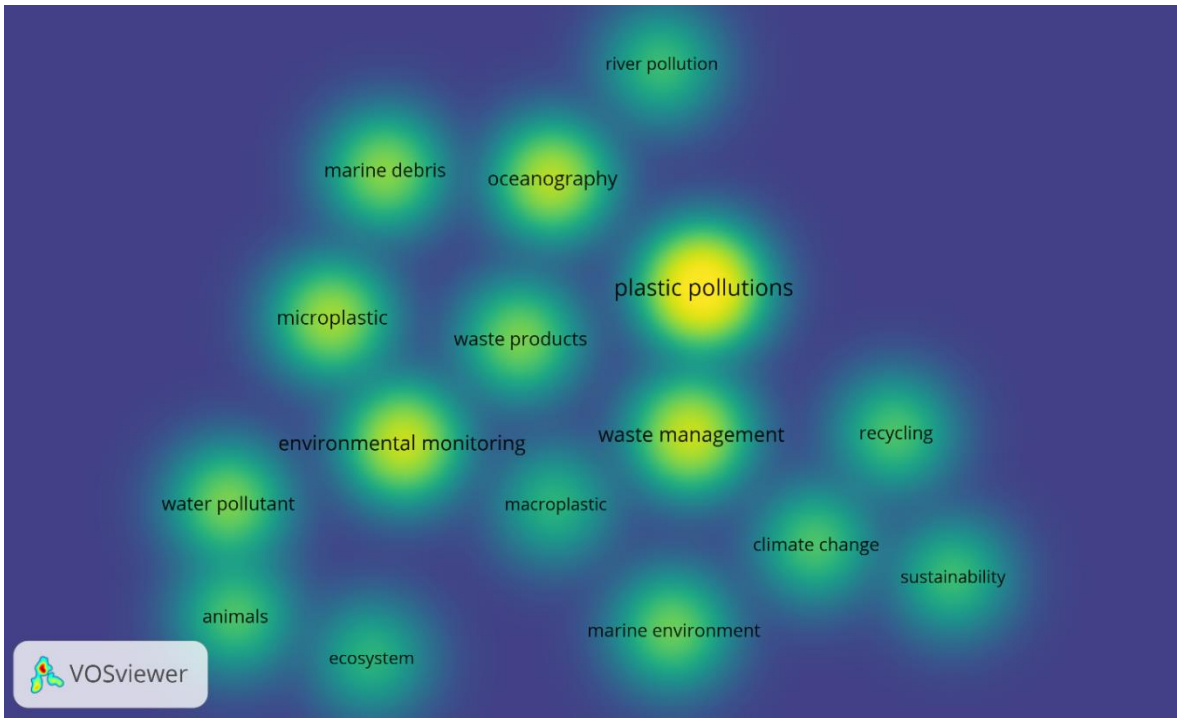

Figure 3. Density Visualization
Source: Data Analysis

The heatmap visualization on Figure 3 illustrates the density of keyword occurrences within the ocean plastic pollution research domain. Keywords such as "plastic pollutions", "environmental monitoring", and "waste management" appear with the brightest yellow hues, indicating they are the most frequently occurring and central themes in the literature. These hotspots suggest that foundational discussions in the field are still strongly rooted in identifying the nature of plastic pollutants, assessing their environmental impacts, and exploring strategies for their management and reduction. On the periphery, keywords like "sustainability", "climate change", "ecosystem", and "animals" are represented in cooler green tones, implying moderate but growing attention. While these themes are not yet as dominant, their presence on the map indicates an expanding focus toward interdisciplinary and systemic approaches. The emerging density around terms such as microplastic, marine debris, and recycling also reflects a shift toward detailed investigations of pollutant forms and actionable mitigation.

3.2 Citation Analysis

Table 1 Top Cited Literature

Citation	Author	Title
1314	[10]	Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic
287	[11]	Rapid aggregation of biofilm-covered microplastics with marine biogenic particles
137	[2]	Viewpoint – Ocean plastic pollution: A convenient but distracting truth?
129	[12]	Sensing Ocean Plastics with an Airborne Hyperspectral Shortwave Infrared Imager
77	[8]	Ocean plastic crisis—Mental models of plastic pollution from remote Indonesian coastal communities
74	[13]	Stakeholder perceptions of marine plastic waste management in the United Kingdom
72	[14]	Ridding our rivers of plastic: A framework for plastic pollution capture device selection
62	[15]	Marine Litter Windrows: A Strategic Target to Understand and Manage the Ocean Plastic Pollution

56	[16]	Plastic photodegradation under simulated marine conditions
54	[17]	Sustainable Development Goals localisation in the tourism sector: lessons from Grootbos Private Nature Reserve, South Africa

Source: Scopus, 2025

3.3 Author Visualization

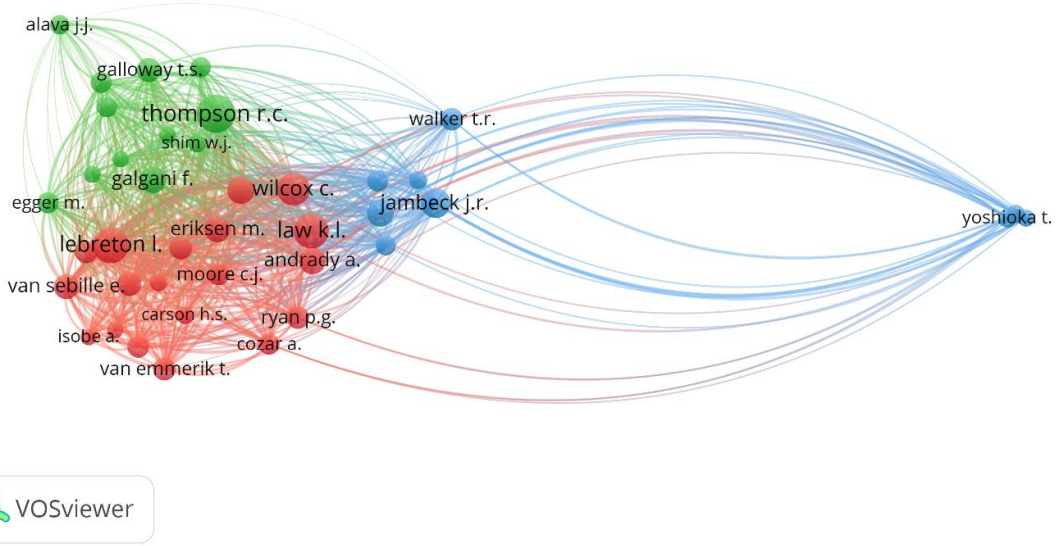

Figure 4. Author Visualization

Source: Data Analysis

The co-authorship network visualization on figure 4 illustrates the structure of scholarly collaboration in the field of ocean plastic pollution research. Authors are grouped into clusters based on the strength of their collaborative relationships, with three dominant clusters clearly visible: a red cluster centered around researchers like lebreton l., law k.l., and wilcox c., focusing on ocean modeling and plastic flow estimation; a green cluster led by thompson r.c., galloway t.s., and shim w.j., likely emphasizing microplastic toxicity and biological impacts; and a blue cluster containing jambeck j.r. and walker t.r., bridging environmental policy and plastic waste management. Notably, yoshioka t. appears in isolation on the far right, acting as a hub node with multiple linkages to all clusters, suggesting their work is highly cited or serves as a methodological reference across distinct research domains

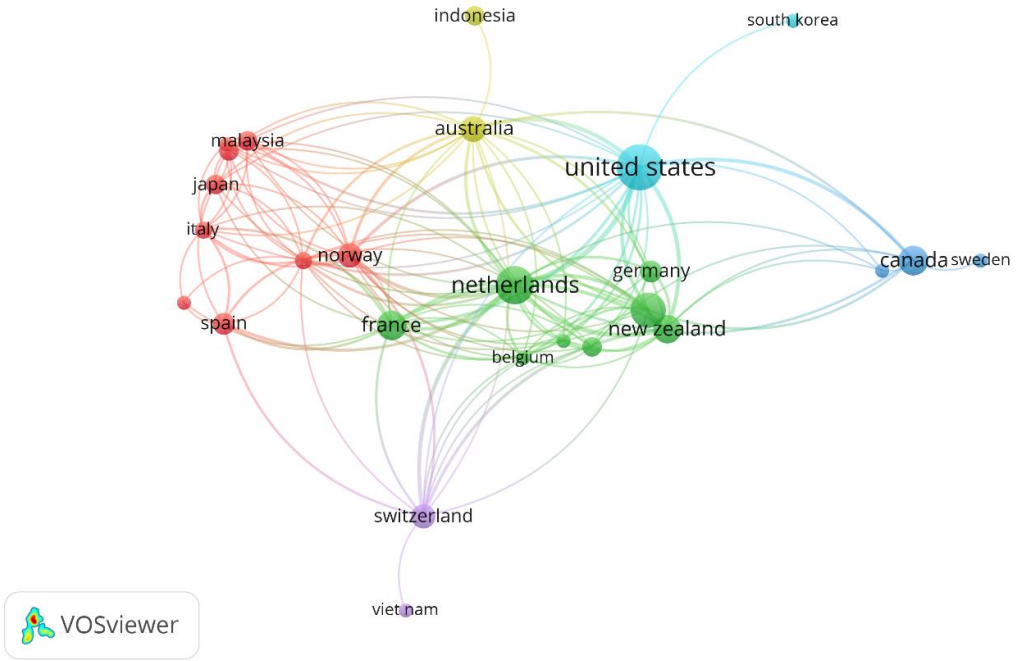

Figure 5. Country Visualization
Source: Data Analysis

This country-level co-authorship network map illustrates the international collaboration landscape in ocean plastic pollution research. Prominent nodes such as the United States, Netherlands, and Canada appear centrally positioned and larger in size, indicating their high publication volume and extensive collaboration ties with other countries. The Netherlands serves as a major connector among European countries (France, Germany, Belgium, Norway) and with global partners such as Australia and the U.S., reflecting its pivotal role in transnational research efforts. The United States shows strong links with both Western and Eastern countries, including Canada, South Korea, and Australia. Meanwhile, Asian countries such as Malaysia, Japan, and Indonesia are clustered more peripherally, with growing connections but relatively lower centrality. The map demonstrates that ocean plastic pollution research is largely driven by Western nations, yet increasingly supported by emerging scientific contributions from Asia-Pacific and European regions, signaling an evolving global effort toward collaborative environmental problem-solving.

Discussion

This bibliometric analysis offers a comprehensive overview of the intellectual structure, thematic evolution, and collaboration dynamics in the domain of ocean plastic pollution research. The results reveal several important patterns, including the rapid growth of publications, the concentration of influential authors and institutions, the emergence of thematic clusters, and the increasing global collaboration across nations. These findings not only illuminate the current state of the field but also provide strategic insights into its future directions.

One of the most notable findings is the centrality of the keyword “plastic pollutions”, which serves as the primary node connecting various subfields. As shown in the keyword co-occurrence map, the thematic structure is divided into three major clusters: (1) marine pathways and pollution dynamics, (2) environmental and ecological monitoring, and (3) policy, sustainability, and waste management. This segmentation reflects the multidisciplinary nature of ocean plastic research, encompassing oceanography, toxicology, waste engineering, ecology, and environmental policy. The clustering of keywords such as marine debris, river pollution, and oceanography around “plastic

pollutions" illustrates the foundational emphasis on understanding the sources, transport mechanisms, and spatial distribution of plastic waste in aquatic systems.

The green cluster, anchored by keywords like microplastic, environmental monitoring, ecosystem, and animals, indicates a maturing body of literature examining the impacts of plastic pollution on marine biota and ecosystems. This research strand has expanded considerably in recent years, driven by advancements in microplastic detection techniques and the growing recognition of microplastics' pervasiveness in food chains. The dense interlinkages within this cluster suggest a well-integrated body of empirical studies focusing on exposure, ingestion, bioaccumulation, and toxicological effects. This evolution aligns with prior reviews emphasizing microplastics as an urgent environmental and public health concern [18], [19].

Meanwhile, the red cluster reflects growing attention toward waste management, recycling, climate change, and sustainability. These terms mark a strategic shift from problem identification to solution formulation, indicating a transition toward systems thinking and circular economy frameworks. Scholars in this domain explore how improved waste infrastructure, extended producer responsibility (EPR), and sustainable material design can mitigate plastic leakage into marine environments. The co-occurrence of climate change in this cluster also suggests an emerging discourse on the intersection between plastic pollution and planetary boundaries, particularly the lifecycle emissions of plastic production and degradation [20].

The overlay visualization further enhances these insights by revealing temporal shifts in thematic prominence. Foundational topics such as oceanography, marine debris, and plastic pollution appear in blue hues, indicating their earlier emergence (circa 2021), while newer themes such as macroplastic, sustainability, and animals are represented in yellow, denoting recent scholarly interest (2022–2023). This temporal layering demonstrates how research is gradually evolving from static assessments of pollution extent to dynamic studies of mitigation, adaptation, and socio-ecological resilience. The increasing appearance of sustainability and climate change suggests that the field is aligning itself with global sustainability agendas, including the United Nations Sustainable Development Goals (SDG 12 and 14).

The density heatmap offers additional depth by highlighting the frequency and centrality of key topics. Unsurprisingly, plastic pollution remains the most concentrated term, followed closely by environmental monitoring and waste management. The spatial brightness of these terms confirms their role as conceptual anchors in the field. However, the lower density of terms like ecosystem, animals, and sustainability—despite their increasing temporal relevance—indicates potential gaps or emerging opportunities for deeper inquiry, especially around ecological recovery, biodiversity impacts, and integrative sustainability science.

The authorship network map unveils an insightful structure of scholarly collaboration and influence. Prominent figures such as Jambeck J.R., Law K.L., and Thompson R.C. stand out as key intellectual contributors with high connectivity and co-authorship frequency. These authors have played crucial roles in shaping the research agenda through seminal works on plastic inputs, marine pathways, and microplastic impacts. The appearance of Yoshioka T. as a highly cited but structurally isolated author suggests their work is conceptually influential across clusters, potentially offering methodological or theoretical insights rather than collaborative fieldwork. This dual presence of dense intra-cluster collaboration and cross-cluster influence illustrates the richness and diversity of knowledge production within this field.

Moreover, the country-level collaboration network emphasizes the global nature of ocean plastic pollution research, with the United States, the Netherlands, and Canada emerging as central hubs. These countries not only produce a large volume of publications but also maintain extensive international partnerships, reinforcing their role in knowledge dissemination and capacity-building. European nations (e.g., Germany, France, Norway) and Asia-Pacific contributors (e.g., Japan, Australia, Malaysia) are also well represented, although countries like Indonesia, Vietnam, and South Korea are more peripheral, suggesting either emerging research capacity or underutilized

collaboration potential. The prominence of multilateral ties between Western and Asian countries is encouraging, especially as developing nations often face the most severe consequences of plastic leakage and marine degradation.

These collaboration patterns reveal both strengths and disparities in the global research ecosystem. While advanced economies lead in funding, infrastructure, and publication, the environmental burden of plastic pollution disproportionately affects low- and middle-income countries. As such, future research should prioritize inclusive collaboration models that empower researchers in the Global South, facilitate technology transfer, and ensure that context-specific solutions are co-produced with local stakeholders. International funding schemes and transdisciplinary research consortia can play a pivotal role in bridging this equity gap. Several limitations must be acknowledged. First, this study is confined to the Scopus database, which, although comprehensive, may exclude some regional publications or non-English contributions. Second, keyword-based bibliometric analysis relies on author-assigned terms, which may vary in precision and granularity. Future research could incorporate full-text mining or natural language processing (NLP) techniques for a deeper semantic analysis. Additionally, incorporating altmetric data or policy citations could help assess the real-world impact of academic research on ocean plastic pollution.

Looking forward, there is a need to strengthen interdisciplinary integration. For example, coupling marine science with behavioral economics and environmental psychology could improve public engagement and plastic reduction behavior. Likewise, embedding indigenous and local knowledge systems into scientific frameworks may offer valuable insights into sustainable practices and community-based waste management. As the field matures, researchers must move beyond siloed approaches and embrace systems-level thinking that connects ecological, technological, and socio-political dimensions of ocean plastic governance.

CONCLUSION

This bibliometric analysis of ocean plastic pollution research reveals a rapidly expanding and multidisciplinary field characterized by distinct thematic clusters, influential scholarly networks, and growing international collaboration. Core research areas have evolved from early studies on plastic sources and marine transport to more recent emphases on microplastics, environmental monitoring, sustainability, and circular waste management. Influential authors and countries such as the United States, the Netherlands, and Canada play pivotal roles in shaping the field's direction, while emerging contributors from Asia and Europe signal a broadening global effort. The integration of sustainability and climate perspectives suggests a paradigm shift toward systemic and solution-oriented research. Despite significant progress, gaps remain in equitable collaboration, ecological recovery studies, and policy translation. Future research should therefore prioritize inclusive, transdisciplinary approaches and strengthen the connection between science, policy, and practice to effectively mitigate the complex challenges of plastic pollution in marine environments.

REFERENCES

[1] E. Van Sebille, C. Spathi, and A. Gilbert, "The ocean plastic pollution challenge: towards solutions in the UK," *Grant. Brief. Pap*, vol. 19, pp. 1–16, 2016.

[2] R. Stafford and P. J. S. Jones, "Viewpoint–Ocean plastic pollution: A convenient but distracting truth?," *Mar. policy*, vol. 103, pp. 187–191, 2019.

[3] R. C. P. Monteiro, J. A. I. do Sul, and M. F. Costa, "Plastic pollution in islands of the Atlantic Ocean," *Environ. Pollut.*, vol. 238, pp. 103–110, 2018.

[4] C. Wabnitz and W. J. Nichols, "Plastic pollution: An ocean emergency," *Mar. Turt. Newsl.*, no. 129, p. 1, 2010.

[5] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," *J. Bus. Res.*, vol. 133, pp. 285–296, 2021.

[6] M. MacLeod, H. P. H. Arp, M. B. Tekman, and A. Jahnke, "The global threat from plastic pollution," *Science (80-.).*,

vol. 373, no. 6550, pp. 61–65, 2021.
[7] E. M. Jepsen and P. J. N. de Bruyn, "Pinniped entanglement in oceanic plastic pollution: a global review," *Mar. Pollut. Bull.*, vol. 145, pp. 295–305, 2019.
[8] A. A. Phelan, H. Ross, N. A. Setianto, K. Fielding, and L. Pradipta, "Ocean plastic crisis—Mental models of plastic pollution from remote Indonesian coastal communities," *PLoS One*, vol. 15, no. 7, p. e0236149, 2020.
[9] N. J. van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, vol. 84, no. 2, pp. 523–538, 2010, doi: 10.1007/s11192-009-0146-3.
[10] L. Lebreton *et al.*, "Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic," *Sci. Rep.*, vol. 8, no. 1, p. 4666, 2018.
[11] J. Michels, A. Stippkugel, M. Lenz, K. Wirtz, and A. Engel, "Rapid aggregation of biofilm-covered microplastics with marine biogenic particles," *Proc. R. Soc. B*, vol. 285, no. 1885, p. 20181203, 2018.
[12] S. P. Garaba *et al.*, "Sensing ocean plastics with an airborne hyperspectral shortwave infrared imager," *Environ. Sci. Technol.*, vol. 52, no. 20, pp. 11699–11707, 2018.
[13] G. McNicholas and M. Cotton, "Stakeholder perceptions of marine plastic waste management in the United Kingdom," *Ecol. Econ.*, vol. 163, pp. 77–87, 2019.
[14] O. K. Helinski, C. J. Poor, and J. M. Wolfand, "Ridding our rivers of plastic: A framework for plastic pollution capture device selection," *Mar. Pollut. Bull.*, vol. 165, p. 112095, 2021.
[15] A. Cózar *et al.*, "Marine litter windrows: a strategic target to understand and manage the ocean plastic pollution," *Front. Mar. Sci.*, vol. 8, p. 571796, 2021.
[16] A. Delre *et al.*, "Plastic photodegradation under simulated marine conditions," *Mar. Pollut. Bull.*, vol. 187, p. 114544, 2023.
[17] K. Dube and G. Nhamo, "Sustainable development goals localisation in the tourism sector: Lessons from Grootbos private nature reserve, South Africa," *GeoJournal*, vol. 86, pp. 2191–2208, 2021.
[18] H. Ritchie and M. Roser, "Plastic pollution," *Our world data*, 2018.
[19] A. T. Williams and N. Rangel-Buitrago, "The past, present, and future of plastic pollution," *Mar. Pollut. Bull.*, vol. 176, p. 113429, 2022.
[20] T. Ballerini *et al.*, "Plastic pollution in the ocean: what we know and what we don't know about." Plastic and Ocean Platform; The camp, 2018.